GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION
SPONSORED PROJECT INITIATION

Date: June 30, 1978

Project Title: Comprehensive Assistance to Undergraduate Science Education Program

Project No: G-33-522

Project Director: Dr. J. A. Bertrand

Sponsor: National Science Foundation, Washington, D.C. 20550

Agreement Period: From 5/26/78 Until ~~11/30/81*~~ 11/30/82
* Includes 6 month flexibility period

Type Agreement: Grant No. SER 78-07018

Amount: $128,900 NSF Funds (G-33-522)
104,639 GIT Contribution (G-33-213)
$233,539 Total

Reports Required: Annual Summary Reports; Final Technical Report.

Sponsor Contact Person (s):

Technical Matters

Mr. John A. Maccini
National Science Foundation
1800 G Street, N.W.
Washington, D.C. 20550
Phone: (202)282-7736

Contractual Matters
(thru OCA)

Ms. Mary Frances O'Connell
Grants Manager - MPE/BBS/SE Branch
National Science Foundation
1800 G Street, N.W.
Washington, D.C. 20550
Phone: (202) 632-2858

Defense Priority Rating: n/a

Assigned to: Chemistry (School/Laboratory)

COPIES TO:

Project Director
Division Chief (EES)
School/Laboratory Director
Dean/Director-EES
Accounting Office
Procurement Office
Security Coordinator (OCA)
Reports Coordinator (OCA)
Library, Technical Reports Section
EES Information Office
EES Reports & Procedures
Project File (OCA)
Project Code (GTRI)
Other

CA-3 (3/76)

SPONSORED PROJECT TERMINATION SHEET

Date 1/31/83

Project Title: Comprehensive Assistance to Undergraduate Science Education Program

Project No: G-33-522

Project Director: Dr. J. Aaron Bertrand

Sponsor: National Science Foundation

Effective Termination Date: 11/30/82

Clearance of Accounting Charges: 1/31/83

Grant/Contract Closeout Actions Remaining:

- ☐ Final Invoice and Closing Documents
- ☒ Final Fiscal Report
- ☒ Final Report of Inventions
- ☒ Govt. Property Inventory & Related Certificate
- ☐ Classified Material Certificate
- ☐ Other _____
- x Patent Questionnaire

Assigned to: Chemistry (School/~~Laboratory~~)

COPIES TO:

Administrative Coordinator	Research Security Services	EES Public Relations (2)
Research Property Management	Reports Coordinator (OCA)	Computer Input
Accounting	Legal Services (OCA)	Project File
Procurement/EES Supply Services	Library	Other Proj Dir

FORM OCA 10:781

G-33-522

First Annual Report

1978 - 1979

CAUSE PROJECT

Effective Utilization of Instrumentation in Undergraduate Chemistry - A Regional Approach

GEORGIA INSTITUTE OF TECHNOLOGY

School of Chemistry

J. A. Bertrand, Project Director

Introduction

The project is a regional approach to problems of instrument maintenance, repair, and access. The objectives of the project are the improvement of undergraduate chemical education through more effective use of instruments in experiments, the improvement of transferability of students between institutions by providing a more uniform background in instrument applications, and the improvement of the education of chemistry majors by providing more experience with modern instrumental techniques. The project involves two-year, four-year, and graduate institutions in exploring ways to achieve these objectives. Activities proposed include a mobile maintenance-repair facility to service equipment at participating institutions, a workshop on routine maintenance of equipment for faculty and staff members, a short course for faculty on the use of instruments in undergraduate courses, a short course for faculty on advanced instrumentation, summer programs on chemical instrumentation for students, and access to instrumental services for research or instruction on an individual basis.

During the first year, the project has proceeded well and, for the most part, has maintained the schedule outlined in the proposal. Major emphasis during the first year was on the mobile Chemistry Electronic Maintenance Service (CHEMS) and that service is now in operation. The initial faculty workshop, relating to CHEMS, was held in December, 1978, and plans are being made for a second workshop in October, 1979. A one-day student workshop on mass spectrometry was conducted in May, 1979, and additional student workshops are planned.

As soon as the grant was activated, purchase procedures were initiated to obtain a motor home, tools, and test instruments for the CHEMS faciltiy. The motor home was delivered in October and the necessary work to modify the interior for

use as an electronic maintenance facility was completed in February. A floor plan of the vehicle is presented as Appendix I. The rear portion is used as living quarters for the operator and the central portion is outfitted with a work bench and space for tools and test equipment. Storage space is provided in this area and in the rear compartment for those instruments that are brought back to the campus for servicing.

Representatives of the schools that had expressed interest in the project were invited to participate in a workshop/planning session in December. A questionnaire was used at the workshop to gather information about local arrangements, scheduling, and billing. One session was devoted to a discussion of operating procedures, policies, and general plans for CHEMS.

The initial service trip started on February 27 and three trips have now been completed. In addition, two local visits have been made and some instruments have been delivered to our campus facility for service. A list of schools visited is included as Appendix II.

In order to evaluate our operation, a brief questionnaire was sent out after each visit; in most cases, an additional follow-up was made by telephone or by personal contact. A copy of the questionnaire used, with a tabulation of responses, is included as Appendix III. In general, the responses were positive and enthusiastic. On one visit, the lack of service manuals created some difficulties and led to some dissatisfaction with the service; the institution involved did not participate in our planning conference and there was insufficient advance planning for the visit.

Considerable time was spent during this period in making arrangements, becoming familiar with locations of departments, becoming familiar with personnel of participating institutions, and organizing the operation of the

facility. Equipment at some institutions had not been serviced in years and some difficult trouble-shooting problems were encountered. Little effort was made to expand the number of schools participating since the emphasis was on developing oeprating procedures rather than making the operation efficient and cost effective. However, billings for the period were approximately $4,500. With more efficient operation and more participants, there should be no difficulty in making the project self-supporting.

A total of 16 institutions are participating in the project and 9 more have expressed interest in participating. Some misunderstandings resulted from our initial correspondence with area institutions; to provide some indication of the cost of regular maintenance service, we asked schools to submit a list of instruments and we provided an estimate for annual maintenance. A number of schools interpreted this estimate as a contract commitment and decided that they could not participate because of budgetary restrictions. We have attempted to clarify the fact that we will arrange service calls on any basis the school wishes, subject only to our hourly rate and our four-hour minimum. Further clarification of this point will be made in a newsletter that will summarize our progress and plans.

Another avenue of expansion has been developed through the NSF funded Atlanta University Resource Center for Science and Engineering (RCSE). Before either project was funded, the possibility of an interaction between CHEMS and RCSE was discussed. We have now worked out a procedure by which minority institutions may request CHEMS instrument repair work through RCSE. A copy of the letter initiating this arrangement is included as Appendix IV and a copy of the memorandum announcing this arrangement to RCSE institutions is attached as Appendix V. The first visit under this arrangement, to Spelman College, was made on June 3.

Workshops for Faculty Members

The project proposal included plans for a series of workshops or short courses on instrument-related topics with the first workshop, to be scheduled prior to the first CHEMS visits, designed to acquaint personnel of participating institutions with the individuals responsible for the program, to discuss arrangements for visits, and to provide elementary training in preventive maintenance and instrument trouble-shooting. Additional workshops on the use of instruments in undergraduate courses and on recent advances in instrumentation were also proposed.

The first workshop was held on Friday, December 8, and Saturday, December 9. Representatives of all schools that had expressed interest in the project were invited and fifteen institutions were represented; a list of participants and their institutions is included as Appendix VI. The program, Appendix VII, consisted of presentations and discussions of three topics: Plans and Procedures for Operating the Mobile Maintenance Facility, Plans for Other Components of the Project, and Preventive Maintenance and Trouble-Shooting. It also included brief tours of some of our instrument facilities to give participants ideas about possible workshops for faculty or students. The workshop was well received, it provided valuable input for project planning, and it generated considerable enthusiasm for all aspects of the project.

Plans are now being made for a second faculty workshop. The original proposal indicated that it would be held in the Spring of 1979 but input from participants indicated that a fall date would be better. Suggestions from workshop participants and from the University System Advisory Committee for Chemistry have led to a tentative decision to offer a workshop in October, 1979, relating to instrumental advances and other changes in the teaching of

undergraduate organic chemistry.

Workshop for Students

The original proposal included the development of a summer instrumentation program to provide instrumentation experience for students from small schools. The proposed program was patterned after the URP program, with emphasis on planned instrumental experiments rather than on research. Prior to awarding the grant, the NSF staff raised questions about this component of the project because of the limited number of students involved. Plans were modified to include short instrumentation workshops for groups of students but details were not worked out. This component was discussed at the planning workshop and participants were encouraged to work with our faculty in exploring possibilities for utilizing our resources with their students.

The first student workshop was held on May 18 for a group of students from Macon Junior College and the plan for this workshop is included as Appendix VIII; a letter from Dr. Dever of Macon Jr. College commenting on the workshop is also included as Appendix IX.

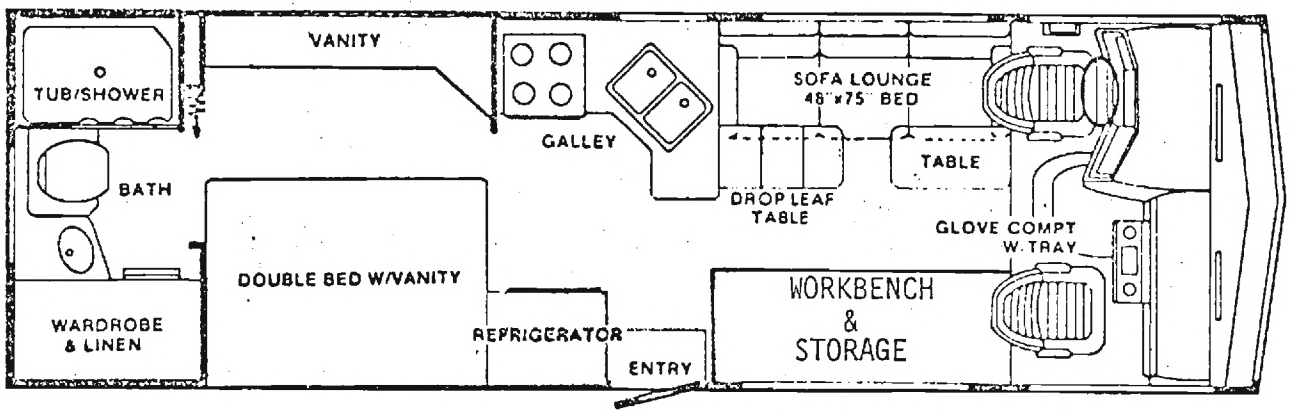
We are encouraging other schools to have their students participate in similar workshops and we are also encouraging suggestions for other types of workshops for students.

Summary

The project is proceeding on schedule with encouraging results from all program components. In the second year, the CHEMS program should establish cost-effective operation that would insure the continuation of this aspect beyond the grant period. By developing stimulating workshops, we hope to create sufficient enthusiasm to continue these on local funding after the grant period.

Georgia Institute of Technology

ChEMS MOTOROHM



PACE ARROW

MODEL R - 28'

Appendix II. CHEMS Trips and Schools Visited

First Trip: February 27 - March 2, 1979

Armstrong State College, Savannah, Georgia
Savannah State College, Savannah, Georgia
Macon Jr. College, Macon, Georgia
Mercer University, Macon, Georgia

Second Trip: March 12-20, 1979

Georgia Southwestern College, Americus, Georgia
Albany State College, Albany, Georgia
Albany Junior College, Albany, Georgia
University of West Florida, Pensacola, Florida

Local Trip: March 26, 1979

Agnes Scott College, Atlanta, Georgia

Third Trip: May 7-10, 1979

Gainesville Junior College, Gainesville, Georgia
Lander College, Greenwood, South Carolina
Erskine College, Due West, South Carolina
Augusta College, Augusta, Georgia

Local Trip: June 5, 1979

Spelman College, Atlanta, Georgia

Total Billed March - May, 1979

$3,487

Appendix III. Questionnaire Used After CHEMS Visits and Responses

GEORGIA INSTITUTE OF TECHNOLOGY

Chemistry Electronics Maintenance Service

Evaluation of Visit

Institution: _____

Department: _____

Person Evaluating: _____

Advance Arrangements for Visit: [8] Good [2] Adequate [ ] Poor

Comments:

Performance of Service: [9] Good [1] Adequate [ ] Poor

Comments:

Results of Service: [8] Good [2] Adequate [ ] Poor

Comments:

Interest in Future Visits: [9] Definite [1] Probable [ ] Not Interested

Comments:

Approximate Date for next visit: _____

Other Comments:

Appendix IV

GEORGIA INSTITUTE OF TECHNOLOGY
ATLANTA, GEORGIA 30332

CHEMISTRY

February 5, 1979

Dr. Paul Brown
Resource Center for Science
and Engineering
Atlanta University
Atlanta, GA 30314

Dear Dr. Brown:

I appreciate your telephone call of Friday, February 2 concerning the possibility of an interaction between our Mobile Maintenance and Repair Service and your Resource Center for Science and Engineering in serving minority institutions in this area. I am enclosing some information on our project as well as some forms that we have asked participating institutions to complete and return to us. One of the forms is a list of instruments to be serviced, the other is a questionnaire concerning arrangements for the Mobile Maintenance and Repair Service.

Our plans for operating the Maintenance and Repair Service are fairly flexible at this time and we would be very happy to work with you to provide the most effective service possible for the Institutions participating in your program. I will be very happy to provide additional information for you or to meet with you to discuss possible arrangements. I look forward to hearing from you.

Sincerely,

J. A. Bertrand, Director
School of Chemistry

JAB/mkw

Enclosures

Appendix V

THE ATLANTA UNIVERSITY

ATLANTA, GEORGIA 30314

RESOURCE CENTER FOR SCIENCE & ENGINEERING

(404) 524-5404

M E M O R A N D U M

TO: Institutional Representatives, Departmental Chairpersons

FROM: Paul L. Brown, Asst. Director for Regional Institutions Component, RCSE PLB

RE: Instrument Repair Service

DATE: May 2, 1979

Enclosed is a copy of the materials which were made available to us by the Chemistry Electronics Maintenance Service (CHEMS) of the Georgia Institute of Technology. We are also enclosing a copy of the RCSE form for requesting equipment repair. When completed, these forms should be returned to the Resource Center, in duplicate.

We have effected an arrangement with CHEMS whereby RCSE will defray the cost of equipment repairs. Please note that funds are only available for repairs. In the event you wish to arrange for maintenance services with CHEMS, you will have to contact the Georgia Institute of Technology and make those arrangements personally. You might also be interested in knowing that Georgia Tech has a regular maintenance/repair program.

Normally CHEMS will make on-site repairs in the course of their visiting institutions on a regular basis, and as soon as CHEMS makes its repair schedule available to us, we will forward it to you. However, you might wish to make use of the non-scheduled repair service at Georgia Tech, particularly in light of the fact that these repairs will be about 40% less than the on-site charges.

If you need additional information, please feel free to call us.

PLB:chh

Enclosures

Appendix VI. Workshop Participants

Dr. Gladys S. Bayse, Spelman College, Atlanta, GA

Dr. Ralph K. Birdwhistell, University of West Florida, Pensacola, FLA

Dr. Billy C. Black, Albany State College, Albany, GA

Dr. Wayne B. Counts, Georgia Southwestern College, Americus, GA

Dr. Dave Dever, Macon Junior College, Macon, GA

Dr. Tom Greenwood, Kings College, Bristol, TN

Dr. Bob Hargrove, Mercer University, Macon, GA

Dr. A. Z. Harris, University of Montevallo, Montevallo, ALA

Mr. Gary McGlaun, Gainesville Junior College, Gainesville, GA

Mr. Guy McMaster, Georgia State University, Atlanta, GA

Dr. Larry Mehne, Covenant College, Lookout Mountain, TN

Ms. Carol C. Mock, Albany Junior College, Albany, GA

Dr. Dan Sweeny, Bellarmine College, Louisville, KY

Dr. Howard Thomas, Erskine College, Due West, S. C.

Ms. Ann Veal, Kennesaw College, Kennesaw, GA

Appendix VII

WORKSHOP/PLANNING SESSION

More Effective Utilization of Instrumentation in Undergraduate Chemistry

Friday Afternoon, December 8, and Saturday Morning, December 9

Boggs Chemistry Building, Georgia Institute of Technology

Atlanta, Georgia

Tentative Schedule

Friday, December 8

2:00 - 5:00 P.M.	Plans and Procedures for Operating the Mobile Maintenance Facility - Mr. Chris Mattingly, Operator of Mobile Maintenance Facility
7:30 - 9:00 P.M.	Plans for Other Components of Project: Faculty Workshops, Student Workshops, Summer Courses, Indidivual Research Projects - Dr. J. A. Bertrand, Director, School of Chemistry

Saturday, December 9

9:00 - 11:00 A.M.	Preventive Maintenance and Trouble Shooting, Mr. Gerald O'Brien, Director of Electronic Shop Operations
11:00 - 12:00 A.M.	Summary and Review Session, Dr. J. A. Bertrand

Travel Expenses Provided:

Transportation:	Commercial Fare of 15¢ per mile for personal automobile (round-trip to Atlanta)
Room:	$26, one-night single-room rate at Atlanta Townehouse (14th Street at I-75 - I-85)
Meals:	$30

Appendix VIII

GEORGIA INSTITUTE OF TECHNOLOGY
ATLANTA, GEORGIA 30332

CHEMISTRY

April 26, 1979

Dr. David Dever
Chemistry Department
Macon Junior College
Macon, GA 31206

Dear Dr. Dever:

We are pleased to hear that you will be with us on May 18 with your students who are interested in mass spectrometry. We have a wide range of mass spectrometers and techniques here at Georgia Tech and will be most happy to spend the day with your students. Both Mr. Larry Abbey and Mr. Dave Bostwick, who are research technicians in mass spectrometry, will also work with your students that day. When you arrive at Tech, look me up in the basement floor, Room B-19, of the Boggs Chemistry Building. We have the following schedule set up for your visit:

I. Brief tour to see the various mass spectrometers

II. Lecture on mass spectrometry

A. Experimental aspects

1. Obtaining a vacuum
2. Production of an ionizing electron beam
3. Production of an ion beam
4. Equations of motion of a charged particle in electrostatic and magnetic fields
5. Mass separation
6. Ion detection with various types of multiplier devices
7. Types of mass spectrometers

B. Theory of mass spectra

1. Electron impact ionization
2. Cross sections for ionization
3. The Franck-Condon principle
4. Mechanisms responsible for fragment ions
5. Spectra of polyatomic molecules

C. Practice

1. Types of samples
2. Sample preparation

III. Demonstrations of:

1. Time of flight mass spectrometer
2. Quadrupole mass spectrometer
3. Magnetic field mass spectrometers -- (a) cycloidal, (b) medium resolution reverse Nier Johnson type, (c) high resolution double focussing
4. Data systems
5. Gas chromatography - mass spectrometry

IV. Hands on practice

1. The obtaining of mass spectra of submitted samples
2. The interpretation of the mass spectra and its relation to the structure of molecules

Have a pleasant trip to Atlanta and we will plan to work with your group from Macon Junior College on the 18th.

Sincerely yours,

T.F. Moran
Professor of Chemistry

TFM:pac

Appendix IX

MACON JUNIOR COLLEGE
MACON, GEORGIA 31206

Division of
Natural Science and Mathematics

A Unit of
The University System
of Georgia

May 22, 1979

Doctor Aaron Bertrand, Chairman
Department of Chemistry
Georgia Institute of Technology
Atlanta, Georgia 30332

Dear Aaron:

To say that Doctor Moran was cooperative and treated our students from Macon Junior cordially is a gross understatement. His arrangements for our visit were just perfect. Through his efforts, our visit has made a quantum difference in CHEM 123 here.

Mssrs. Abbey and Bostwick were most helpful. It is real dedication to stay around until 5:30 p.m. on a Friday afternoon. I would be grateful if you would repeat my thanks to the group.

Sincerely,

David F. Dever
Professor of Chemistry

DFD:jr

SECOND ANNUAL REPORT

. 1979 - 1980

CAUSE PROJECT

EFFECTIVE UTILIZATION OF INSTRUMENTATION IN UNDERGRADUATE CHEMISTRY - A REGIONAL APPROACH

GEORGIA INSTITUTE OF TECHNOLOGY

School of Chemistry

J. A. Bertrand, Project Director

The project is a regional approach to problems of instrument maintenance, repair, and access. The objectives of the project are the improvement of undergraduate chemical education through more effective use of instruments in experiments, the improvement of transferability of students between institutions by providing a more uniform background in instrument applications, and the improvement of the education of chemistry majors by providing more experience with modern instrumental techniques. The project involves two-year, four-year, and graduate institutions in exploring ways to achieve these objectives. Activities proposed include a mobile maintenance-repair facility to service equipment at participating institutions, a workshop on routine maintenance of equipment for faculty and staff members, a short course for faculty on the use of instruments in undergraduate courses, a short course for faculty on advanced instrumentation, summer programs on chemical instrumentation for students, and access to instrumental services for research or instruction on an individual basis.

During the second year, the project proceeded well and, for the most part, maintained the schedule outlined in the proposal. The major emphasis continued to be the mobile Chemistry Electronic Maintenance Service (CHEMS) but additional emphasis was placed on student workshops. Problems in correlating our plans with those of the Chemistry Advisory Committee of the University System of Georgia resulted in a postponement of our planned faculty workshop from the fall of 1980 to the fall of 1981.

The CHEMS operation expanded from 16 to 36 institutions ranging in location from Louisville, Kentucky to Orlando, Florida. A list of the participating schools is included as Appendix I. Income from charges to participants amounted to about $16,000. We have continued to send a questionnaire after our initial visit and the responses have been excellent; almost all schools have expressed interest in continuing. Our interaction with the Atlanta

University Resource Center for Science and Engineering, in which we provide service to minority schools and RCSE pays our expenses, has continued and four schools obtained instrument repairs through this arrangement.

Several problems relating to CHEMS have developed and we are in the process of dealing with these. First, differences in budgets and differences in the amount of equipment affects the frequency at which different schools expect visits; this makes it difficult for us to plan efficient tours. Second, the general willingness to have instruments transported to our shop for service avoids extended stays on the road and is an advantage in planning trips; it is, however, difficult to return these instruments in a reasonable and cost-effective way. We are trying to develop better guidelines for our trips and for handling instruments in our shop.

A third and more significant problem concerns the staffing of CHEMS. Our technician, Mr. Chris Mattingly, has done an excellent job in setting up and handling the CHEMS facility but he resigned effective June 30, 1980, to take a position with a private company. We have two other technicians in our shop but lack of training or prior commitments make it impossible for either to handle the CHEMS position at this time. We are trying to hire a replacement but we may have to curtail our mobile operation for a while. During this period, we will make arrangements to handle as much of the equipment as possible in our shop where our technicians can be supervised.

During the year student workshops were provided for groups from Edward Waters College (2 day workshop on Mass Spectroscopy, Chromatography, and Nuclear Magnetic Resonance Spectroscopy), Gordon Junior College (1 day workshop on Nuclear Magnetic Resonance Spectroscopy), and Macon Junior College (1 day workshop on Mass Spectroscopy and Nuclear Magnetic Resonance Spectroscopy). The one with Macon Junior College was most successful because of the efforts of Dr. Dave Dever of Macon Jr. College and because of our experience with that

group last year. Dr. Dever did an excellent job of preparing his students for the workshop through advance coverage of background material on the instrumental methods. The students were all from a course with a project-type laboratory and the workshop involved spectra of compounds from their projects. Some spectra were run in advance on samples provided by Dr. Dever and other spectra were run during the workshop on samples brought by the students. We are using this workshop as a model to encourage faculty from other schools to work with us in developing workshops to meet their specific needs.

Faculty and staff members visited several schools to present seminars relating to instrumentation. Mr. Larry Abbey of our Mass Spectroscopy Laboratory presented a seminar at Georgia College, Dr. R. F. Browner presented a seminar on atomic absorption spectroscopy at the University of Tennessee at Chattanooga, and Dr. J. A. Bertrand presented a seminar on x-ray structure determinations at Fisk University and at Eckerd College. Instrument assistance in support of research was provided to Dr. Gross from the University of Tennessee at Chattanooga (NMR) and to Dr. Elliott of Fisk University (x-ray diffraction).

A faculty workshop is planned for October, 1980, on modern instrumentation in organic chemistry. The workshop will include sessions on the impact of instrumentation on the teaching of organic chemistry, the use of instrumentation in undergraduate laboratories, and recent advances in instrumentation.

Except for a delay in the faculty workshop, the project has proceeded on schedule and has been received enthusiastically by schools in the Southeast. Although presently facing a critical period due to the resignation of our electronic technician, we expect only a short interruption in developing a vigorous and continuing program.

APPENDIX I. Schools Participating in CHEMS Program

Agnes Scott College
Albany Junior College
Albany State College[2]
Allen University[1,2]
Armstrong State College
Atlanta University[1]
Augusta College
Bellarmine College[1]
Brunswick Junior College[1]
Columbus College[1]
Cumberland College[1]
Eckerd College[1]
Erskine College
Fisk University[1]
Fort Valley State College[1]
Furman University[1]
Gainesville Junior College
Georgia College[1]
Georgia Southern College[1]
Georgia Southwestern College
Gulf Coast Junior College[1]
Kennesaw College
Lander College
Macon Junior College
Maryville College[1]
Mercer University
Middle Georgia College[1]
Middle Tennessee State University[1]
Paine College[1,2]
Savannah State College
Spelman College[2]
Tennessee Technological University[1]
University of Central Florida[1]
University of West Florida
Valdosta State College[1]
Western Kentucky University[1]

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[1]Participated for the first time this year.

[2]Participated through Atlanta University Resource Center for Science and Engineering.

G-33-522

NATIONAL SCIENCE FOUNDATION
Washington, D.C. 20550

FINAL PROJECT REPORT
NSF FORM 98A

PLEASE READ INSTRUCTIONS ON REVERSE BEFORE COMPLETING

PART I–PROJECT IDENTIFICATION INFORMATION

1. Institution and Address	2. NSF Program	3. NSF Award Number
Georgia Institute of Tech.	CAUSE	SER 78-07018
	4. Award Period	5. Cumulative Award Amount
	From 5/78 To 11/82	$128,900

6. Project Title

Effective Utilization of Instrumentation in Undergraduate Chemistry - A Regional Approach

PART II–SUMMARY OF COMPLETED PROJECT *(FOR PUBLIC USE)*

The project was a regional approach to problems of instrument maintenance, repair, and access. The project involved two-year, four-year, and graduate institutions in exploring ways to improve undergraduate chemical education through more effective use of instruments in experiments, to improve transferability of students between institutions by providing a more uniform background in instrument applications, and to improve the education of chemistry majors by providing more experience with modern instruments and instrumental techniques. The most successful component of the project was a mobile Chemistry Electronics Maintenance Service (CHEMS) which has demonstrated a cost-effective way of providing instrument maintenance and repair for small schools; CHEMS will be continued as a self-supporting project. The project also demonstrated an effective way of providing instrumentation experience for students in two-year colleges. Different types of faculty workshops were explored.

PART III–TECHNICAL INFORMATION *(FOR PROGRAM MANAGEMENT USES)*

1. ITEM *(Check appropriate blocks)*	NONE	ATTACHED	PREVIOUSLY FURNISHED	TO BE FURNISHED SEPARATELY TO PROGRAM	
				Check (√)	Approx. Date
a. Abstracts of Theses	X				
b. Publication Citations	X				
c. Data on Scientific Collaborators	X				
d. Information on Inventions	X				
e. Technical Description of Project and Results		X			
f. Other *(specify)*					

2. Principal Investigator/Project Director Name *(Typed)*	3. Principal Investigator/Project Director Signature	4. Date
J. A. Bertrand	✓	Jan. 4, '83

NSF Form 98A (5-78) Supersedes All Previous Editions

Form Approved OMB No. 99R0013

INSTRUCTIONS FOR FINAL PROJECT REPORT
(NSF FORM 98A)

This report is due within 90 days after the expiration of the award. It should be submitted in two copies to:

National Science Foundation
Division of Grants and Contracts
Post-Award Projects Branch
1800 G Street, N.W.
Washington, D.C. 20550

INSTRUCTIONS FOR PART I

These identifying data items should be the same as on the award documents.

INSTRUCTIONS FOR PART II

The summary (about 200 words) must be self-contained and intelligible to a scientifically literate reader. Without restating the project title, it should begin with a topic sentence stating the project's major thesis. The summary should include, if pertinent to the project being described, the following items:

- The primary objectives and scope of the project.
- The techniques or approaches used only to the degree necessary for comprehension.
- The findings and implications stated as concisely and informatively as possible.

This summary will be published in an annual NSF report. Authors should also be aware that the summary may be used to answer inquiries by nonscientists as to the nature and significance of the research. Scientific jargon and abbreviations should be avoided.

INSTRUCTIONS FOR PART III

Items in Part III may, but need not, be submitted with this Final Project Report. Place a check mark in the appropriate block next to each item to indicate the status of your submission.

a. Self-explanatory.
b. For publications (published and planned) include title, journal or other reference, date, and authors. Provide two copies of any reprints as they become available.
c. Scientific Collaborators: provide a list of co-investigators, research assistants and others associated with the project. Include title or status, e.g. associate professor, graduate student, etc.
d. Briefly describe any inventions which resulted from the project and the status of pending patent applications, if any.
e. Provide a technical summary of the activities and results. The information supplied in proposals for further support, updated as necessary, may be used to fulfill this requirement.
f. Include any additional material, either specifically required in the award instrument (e.g. special technical reports or products such as films, books, studies) or which you consider would be useful to the Foundation.

FINAL REPORT

N.S.F. CAUSE PROJECT

Effective Utilization of Instrumentation in Undergraduate Chemistry - A Regional Approach

GEORGIA INSTITUTE OF TECHNOLOGY

School of Chemistry

J. A. Bertrand, Project Director

INTRODUCTION

The project was a regional approach to problems of instrument maintenance, repair, and access. The objectives of the project were the improvement of undergraduate chemical education through more effective use of instruments in experiments, the improvement of transferability of students between institutions by providing a more uniform background in instrument applications, and the improvement of the education of chemistry majors by providing more experience with modern instruments and instrumental techniques. The project involved two-year, four-year, and graduate institutions exploring ways to achieve these objectives. Activities proposed included a mobile maintenance/repair facility to service equipment at participating institutions, workshops on routine maintenance of equipment for faculty and staff members, short courses for faculty on the use of instruments in undergraduate courses, short course for faculty on advanced instrumentation, summer programs on chemical instrumentation for students, and access to instrumental services for research or instruction on an individual basis.

The project grew out of a conference hosted by the Georgia Tech School of Chemistry in April, 1977, to explore ways in which a graduate institution could interact with predominantly undergraduate institutions. Most of the interactions suggested by representatives of about 40 chemistry departments were related to instrumentation problems; instrument maintenance and repair appeared to be almost universal problems and many schools indicated that their instructional programs were seriously affected by major instruments being out or operation for

a complete term or year. Following the conference, Georgia Tech's School of Chemistry collected the suggestions into a proposal that was submitted to the N.S.F. CAUSE Program.

The Georgia Tech School of Chemistry was in an excellent position to handle such a project. Because of active research programs, the School's facilities included a wide range of state-of-the-art instrumentation and the faculty included expertise in most instrumental methods. In addition, the School had recognized serveal years earlier the importance of quality electronics service for the support of its research and instructional programs and had set up excellent support facilities under the direction of Mr. Gerald O'Brien. Mr. O'Brien expressed interest in directing the proposed maintenance/repair service and Mr. Chris Mattingly, one of the department's electronic technicians, expressed interest in operating the service.

The proposed project, after modification to remove the summer program for students, was funded as a Special Project in 1978.

SUMMARY OF ACTIVITIES

As soon as the grant was activated, purchase procedures were initiated to obtain a motor home, tools, and test instruments for the mobile Chemistry Electronic Maintenance Service (CHEMS). The motor home was delivered in October,1978, and the necessary work to modify the interior for use as an electronic maintenance facility was completed in February, 1979. A floor plan of the vehicle is presented as Appendix I. The rear portion is used as living quarters for the operator and the central portion is outfitted with a work bench and space for tools and

test equipment. Storage space is provided in this area and in the rear compartment for those instruments that are brought back to the campus for servicing. A microcomputer/test instrument provides additional test capabilities as well as the capability to maintain service records and inventories; the instrument was built from components using plans for a departmental instrument designed by Mr. O'Brien.

Representatives of the schools that had expressed interest in the project were invited to participate in a Workshop/Planning Session in December, 1978. Part of the conference was dedicated to a presentation on instrument maintenance, trouble-shooting and minor repairs, and on evaluation of instruments before purchase. A questionnaire was used to gather information about local arrangements, scheduling, and billing of the CHEMS service and part of the conference was devoted to a discussion of operating procedures, policies, and general plans for CHEMS. A copy of the program is included as Appendix II.

The initial service trip was a three-day trip that started on February 27, 1979 and included visits to Macon Junior College and Mercer University in Macon, Ga., and to Armstrong State College and Savannah State College in Savannah, Ga.. Considerable time was spent during this period in making arrangements, becoming familiar with locations of departments, becoming familiar with personnel of participating institutions, and organizing the operation of the service. Equipment at some institutions had not been serviced in years and some difficult trouble-shooting problems were encountered. Little effort was made to expand the number of school participating since the emphasis was on developing operating procedures rather than on making the operation efficient and cost-effective. However, billings for the period

indicated that there should be no difficulty in making the project self-supporting.

In order to evaluate the operation, a brief questionnaire was sent out after each visit; in most cases, an additional follow-up was made by telephone or by personal contact. In general, the responses were positive and enthusiastic. On one visit, the lack of service manuals created some difficulty and led to some dissatisfaction with the service; the institution involved did not participate in the planning workshop and there was insufficient advance planning for the visit.

Some misunderstandings resulted from initial correspondence with area institutions; to provide some indication of the cost of regular maintenance service, schools were asked to submit a list of their instrumentation and we provided an estimate for annual maintenance. A number of schools interpreted this estimate as a contract commitment and decided that they could not participate because of budgetary restrictions. Part of the problem was with the estimates that we provided - they were based on regular preventive maintenance (as well as repair) and they were based on a higher level of usage than was appropriate for most of the schools involved. Further correspondence clarified the fact that service calls would be arranged on any basis the school requested, subject only to an hourly rate and a four-hour minimum.

During this period, the service was also expanded through cooperation with the N.S.F-funded Atlanta University Resource Center for Science and Engineering (RCSE). Under the arrangement developed, minority institutions could request CHEMS instrument repairs through RCSE; service was provided in the usual was but RCSE was billed. The

first visit under this arrangement was made on June 3,1979.

The first student workshop was held on May 18,1979, for a group of students from Macon Junior College and the plan for this workshop in included as Appendix III; a letter from Dr. Dever of Macon Jr. College commenting on the workshop is included as Appendix IV. The workshop provided experience with instrumentation and supplemented the course work provided by Dr. Dever.

During the second year of operation, the number of participants in the CHEMS Program increased from 16 to 36 institutions and several problems developed. First, differences in budgets and differences in the amount of equipment affects the frequency at which different schools expect visits; this made it difficult to plan efficient tours. This problem was later partially solved by setting up zones for trips of differing duration based on distance of the school from Atlanta. The current scheme is outlined in Appendix V. Second, the ability to transport instruments to our shop for service avoided extended stays on the road and was an advantage in planning trips but it was difficult to return those instruments in a reasonable and cost-effective way. This problem has been solved through use of UPS and other shipping means.

A third and more significant problem concerned the staffing of CHEMS when Mr. Mattingly resigned in June, 1980, to take a position with a private company. The other technicians in the department could not take over because of lack of training or inability to be away due to educational commitments. In spite of extensive efforts, an acceptable candidate was not located for almost a year. During this period, operation of the mobile service was discontinued but efforts were made to handle as much of the equipment as possible in our shop where the

technicians could be supervised.

During the second year, student workshops were provided for groups from Edward Waters College (2-day workshop on Mass Spectroscopy, Chromatography, and Nuclear Magnetic Resonance Spectroscopy), Gordon Junior College (1-day workshop on Nuclear Magnetic Resonance Spectroscopy), and Macon Junior College (1-day workshop on Mass Spectroscopy and Nuclear Magnetic Resonance Spectroscopy). The one with Macon Junior College was most successful because of the efforts of Dr. Dave Dever of Macon Junior College and because of previous experience with that group. Dr. Dever did an excellent job of preparing his students for the workshop through advance coverage of background material on instrumental methods; the students were from a course with a project-type laboratory and the workshop involved spectra of compounds from their projects. Some spectra were run in advance on samples provided by the group and other spectra were run during the workshop on samples brought by the students. It is clear that the success of this type of program is very dependent on the commitment, interest, and ability of the faculty member from the participating school.

As another means of reaching students, faculty and staff members visited several schools to present seminars relating to instrumentation. Mr. Larry Abbey of our Mass Spectroscopy Laboratory preseneted a seminar at Georgia College, Dr. R. F. Browner presented a seminar on atomic absorption spectroscopy at the University of Tennessee at Chattanooga, and Dr. J. A. Bertrand presented seminars on x-ray structure determinations at Fisk University and at Eckerd College. Instrument assistance in support of research was provided to Dr. Gross from the University of Tennessee at Chattanooga (NMR) and to Dr. Elliott of Fisk

University (x-ray diffraction); in both cases, the request for services followed a seminar visit by one of our faculty and indicates the need for acquainting individual faculty members in participating schools with the services available.

During the third year of the project, an instrumentation workshop, entitled "Instrumentation and Undergraduate Organic Chemistry", was held on October 17-18, 1980. A workshop schedule is included as Appendix VI. Forty faculty members from schools throughout the Southeast attended and the follow-up evaluation was very positive. The presentation entitled "Alternative Explanations of Fundamental Organic Reactions" by Drs. Burgess and Liotta was particularly well-received and participants expressed interest in a workshop dedicated to this topic. Although beyond the scope of the current instrumentation project, attempts are being made to offer such a workshop as a separate project.

The problem of staffing CHEMS was solved in March, 1981, with the hiring of Mr. Harrie Buswell. After a three-month training period, CHEMS was back in service and reports from participating schools have been excellent. The service has now been expanded to over 50 schools; a map indicating the location of schools that have participated is included as Appendix VII. Current rates of $48 per hour for mobile service and $32 per hour for shop service are considerably less than commercial service but appear sufficient to make the operation self-supporting. There is still concern that some schools may have to drop out of the program because of budget limitations.

RESULTS AND EVALUATION

The project overall has been very successful and several components will be continued beyond the grant period. The CHEMS service has been the most successful component and has demonstrated a cost-effective way of providing instrument maintenance on a regional basis. CHEMS has enthusiastic support from all of the schools participating and it will be continued as a self-supporting project.

CHEMS was publicized through a presentation at the 184th ACS National Meeting in Kansas City, Missouri in September, 1982, and the abstract of that presentation is included as Appendix VIII. As a result of the presentation, a brief description of the project appeared as a news item in C&EN (Sept. 27,1982) and prompted several inquiries about the service. We have supplied detailed information to Professor Pierre Crabbe of the University of Missouri, who expressed interest in setting up similar services in developing countries through the International Organization for Chemical Sciences in Development, and to Mr. Howard Metz of N.I.H., who expressed interest in setting up similar services in Egypt through a contract arrangement between N.I.H. and the Egyptian government. We had earlier supplied information to Professor John Marquart of Eastern Illinois University who had expressed interest in organizing a similar service in that region.

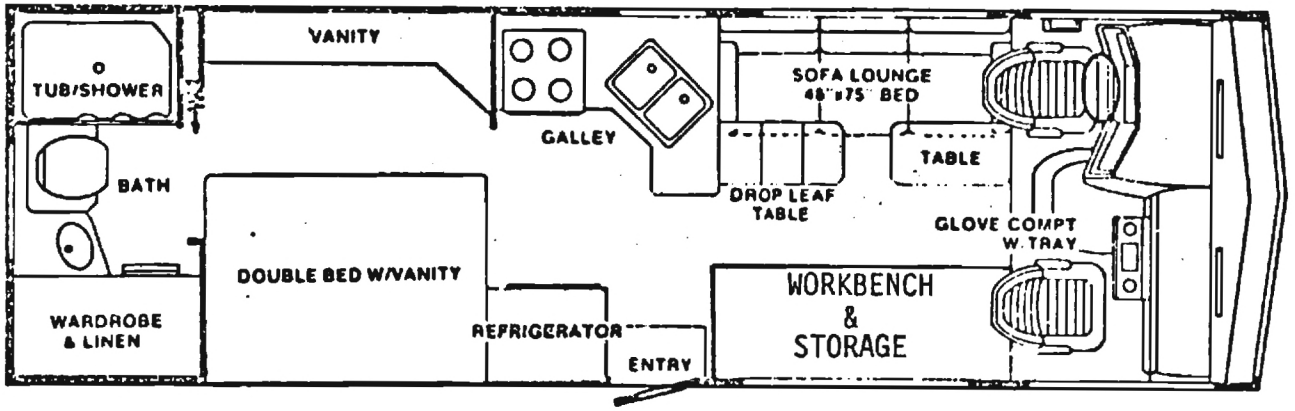
The student workshops have generated limited interest but they seem to serve an important need for two-year colleges that have very little instrumentation. Their success depends on the interest and commitment of the faculty member involved and efforts will be made to interest more faculty members from nearby two-year schools; these faculty members will

be encouraged to design experiments that would benefit from this type of instrumentation workshop.

There is considerable interest in faculty workshops or short courses and some type of program will be continued. Short courses on advanced instrumentation are being offered by the local ACS section and by various instrument manufacturers and there seems little need for additional offerings in this area. The workshop on preventive maintenance, trouble-shooting, and minor repairs was very successful and will be repeated within the next year or two; it is not the type of workshop that needs to be offered frequently. Workshops on the use of instrumentation in undergraduate courses provide a good opportunity for faculty members to share successful ideas; this type of workshop appears to be more valuable if limited to one type of undergraduate course (such as organic) but <u>not</u> limited in scope to instrumentation problems.

The interactions between Georgia Tech and two-year and four-year schools in the Southeast have been very positive and very constructive. We look forward to continuing the CHEMS service and the workshops; we also look forward to exploring other interactions of this type.

Georgia Tech School of Chemistry
CHEMS Motorhome



PACE ARROW
Model R - 28'

APPENDIX II

WORKSHOP/PLANNING SESSION

More Effective Utilization of Instrumentation in Undergraduate Chemistry

Friday Afternoon, December 8, and Saturday Morning, December 9

Boggs Chemistry Building, Georgia Institute of Technology
Atlanta, Georgia

Tentative Schedule

Friday, December 8

2:00 - 5:00 P.M.	Plans and Procedures for Operating the Mobile Maintenance Facility - Mr. Chris Mattingly, Operator of Mobile Maintenance Facility
7:30 - 9:00 P.M.	Plans for Other Components of Project: Faculty Workshops, Student Workshops, Summer Courses, Indidivual Research Projects - Dr. J. A. Bertrand, Director, School of Chemistry

Saturday, December 9

9:00 - 11:00 A.M.	Preventive Maintenance and Trouble Shooting, Mr. Gerald O'Brien, Director of Electronic Shop Operations
11:00 - 12:00 A.M.	Summary and Review Session, Dr. J. A. Bertrand

Travel Expenses Provided:

Transportation:	Commercial Fare of 15¢ per mile for personal automobile (round-trip to Atlanta)
Room:	$26, one-night single-room rate at Atlanta Townehouse (14th Street at I-75 - I-85)
Meals:	$30

APPENDIX III

GEORGIA INSTITUTE OF TECHNOLOGY
ATLANTA, GEORGIA 30332

CHEMISTRY

April 26, 1979

Dr. David Dever
Chemistry Department
Macon Junior College
Macon, GA 31206

Dear Dr. Dever:

We are pleased to hear that you will be with us on May 18 with your students who are interested in mass spectrometry. We have a wide range of mass spectrometers and techniques here at Georgia Tech and will be most happy to spend the day with your students. Both Mr. Larry Abbey and Mr. Dave Bostwick, who are research technicians in mass spectrometry, will also work with your students that day. When you arrive at Tech, look me up in the basement floor, Room B-19, of the Boggs Chemistry Building. We have the following schedule set up for your visit:

I. Brief tour to see the various mass spectrometers

II. Lecture on mass spectrometry

A. Experimental aspects

1. Obtaining a vacuum
2. Production of an ionizing electron beam
3. Production of an ion beam
4. Equations of motion of a charged particle in electrostatic and magnetic fields
5. Mass separation
6. Ion detection with various types of multiplier devices
7. Types of mass spectrometers

B. Theory of mass spectra

1. Electron impact ionization
2. Cross sections for ionization
3. The Franck-Condon principle
4. Mechanisms responsible for fragment ions
5. Spectra of polyatomic molecules

C. Practice

1. Types of samples
2. Sample preparation

III. Demonstrations of:

1. Time of flight mass spectrometer
2. Quadrupole mass spectrometer
3. Magnetic field mass spectrometers -- (a) cycloidal, (b) medium resolution reverse Nier Johnson type, (c) high resolution double focussing
4. Data systems
5. Gas chromatography - mass spectrometry

IV. Hands on practice

1. The obtaining of mass spectra of submitted samples
2. The interpretation of the mass spectra and its relation to the structure of molecules

Have a pleasant trip to Atlanta and we will plan to work with your group from Macon Junior College on the 18th.

Sincerely yours,

T.F. Moran
Professor of Chemistry

TFM:pac

APPENDIX IV

MACON JUNIOR COLLEGE
MACON, GEORGIA 31206

Division of
Natural Science and Mathematics

A Unit of
The University System
of Georgia

May 22, 1979

Doctor Aaron Bertrand, Chairman
Department of Chemistry
Georgia Institute of Technology
Atlanta, Georgia 30332

Dear Aaron:

To say that Doctor Moran was cooperative and treated our students from Macon Junior cordially is a gross understatement. His arrangements for our visit were just perfect. Through his efforts, our visit has made a quantum difference in CHEM 123 here.

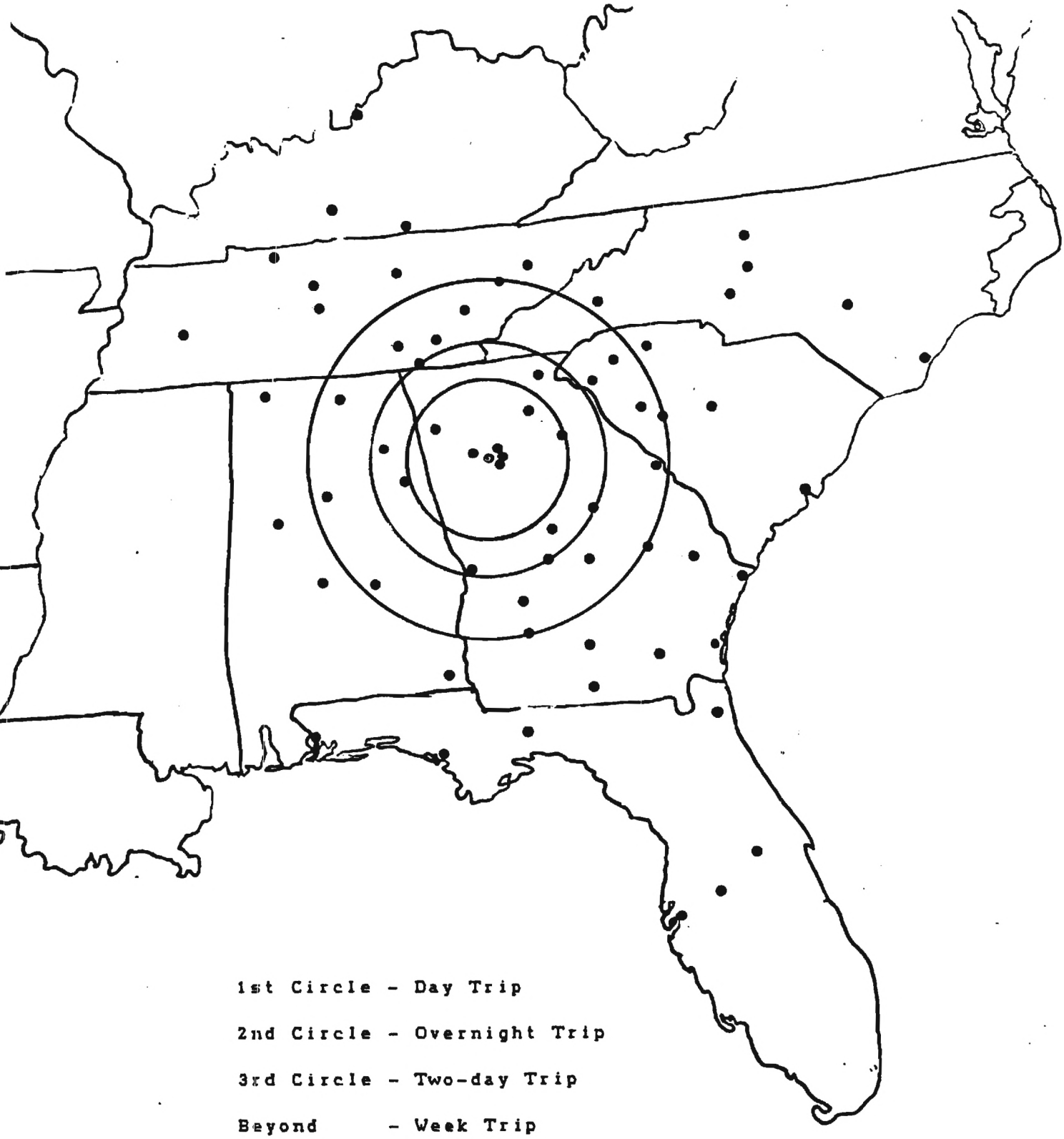
Mssrs. Abbey and Bostwick were most helpful. It is real dedication to stay around until 5:30 p.m. on a Friday afternoon. I would be grateful if you would repeat my thanks to the group.

Sincerely,

David F. Dever
Professor of Chemistry

DFD:jr

APPENDIX V



1st Circle - Day Trip

2nd Circle - Overnight Trip

3rd Circle - Two-day Trip

Beyond - Week Trip

APPENDIX VI

WORKSHOP
INSTRUMENTATION AND UNDERGRADUATE ORGANIC CHEMISTRY
OCTOBER 17-18, 1980
BOGGS CHEMISTRY BUILDING
GEORGIA INSTITUTE OF TECHNOLOGY

FRIDAY, OCTOBER 17

1:00-1:30 P.M.	Registration (Room 1-90 Boggs)
1:30-4:30 P.M.	Instrumentation in Undergraduate Organic Chemistry (Room 2-28 Boggs
1:30-3:15 P.M.	Presentation by Dr. John T. Gupton (University of Central Florida), Dr. Homer A. Smith (Hampden-Sydney College), and Dr. Drury S. Caine (Georgia Tech) on Organic Experiments and Programs involving the use of instrumentation
3:15-3:30 P.M.	Coffee Break (Room 3-44 Boggs)
3:30-4:00 P.M.	Brief Presentation* by Workshop Participants on Unique Experiments, Programs, and Ideas Involving Instrumentation in Organic Chemistry
4:00-4:30 P.M.	General Discussion
4:30-7:00 P.M.	Free Time and Dinner
7:00-9:00 P.M.	Recent Advances in Organic Instrumentation: Mass Spectrometry (Room 2-28 Boggs) Presentations and Demonstrations by Dr. Tom Moran, Mr. Larry Abbey, and Mr. Dave Bostwick of Georgia Tech

SATURDAY, OCTOBER 18

9:00-11:30 A.M.	Trends in Teaching Organic Chemistry (Room 2-28 Boggs)
9:00-10:20 A.M.	Alternative Explanations of Fundamental Organic Reaction by Dr. Edward Burgess and Dr. Charles Liotta of Georgia Tech
10:20-10:35 A.M.	Coffee Break (Room 3-44 Boggs)
10:35-11:05 A.M.	Industrial Chemistry Topics in Undergraduate Organic Chemistry by Dr. Guy Mattson of University of Central Florida
11:05-11:30 A.M.	Brief Presentations* by Workshop Participants on Various New Trends (for example, more emphasis on "biological relevance") in the Teaching of Organic Chemistry
11:30-12:00 Noon	General Discussion
12:00- 1:00 P.M.	Lunch - (For those who wish to eat in the Student Center, you may go through the cafeteria line and then carry your tray to Room 301 to eat)

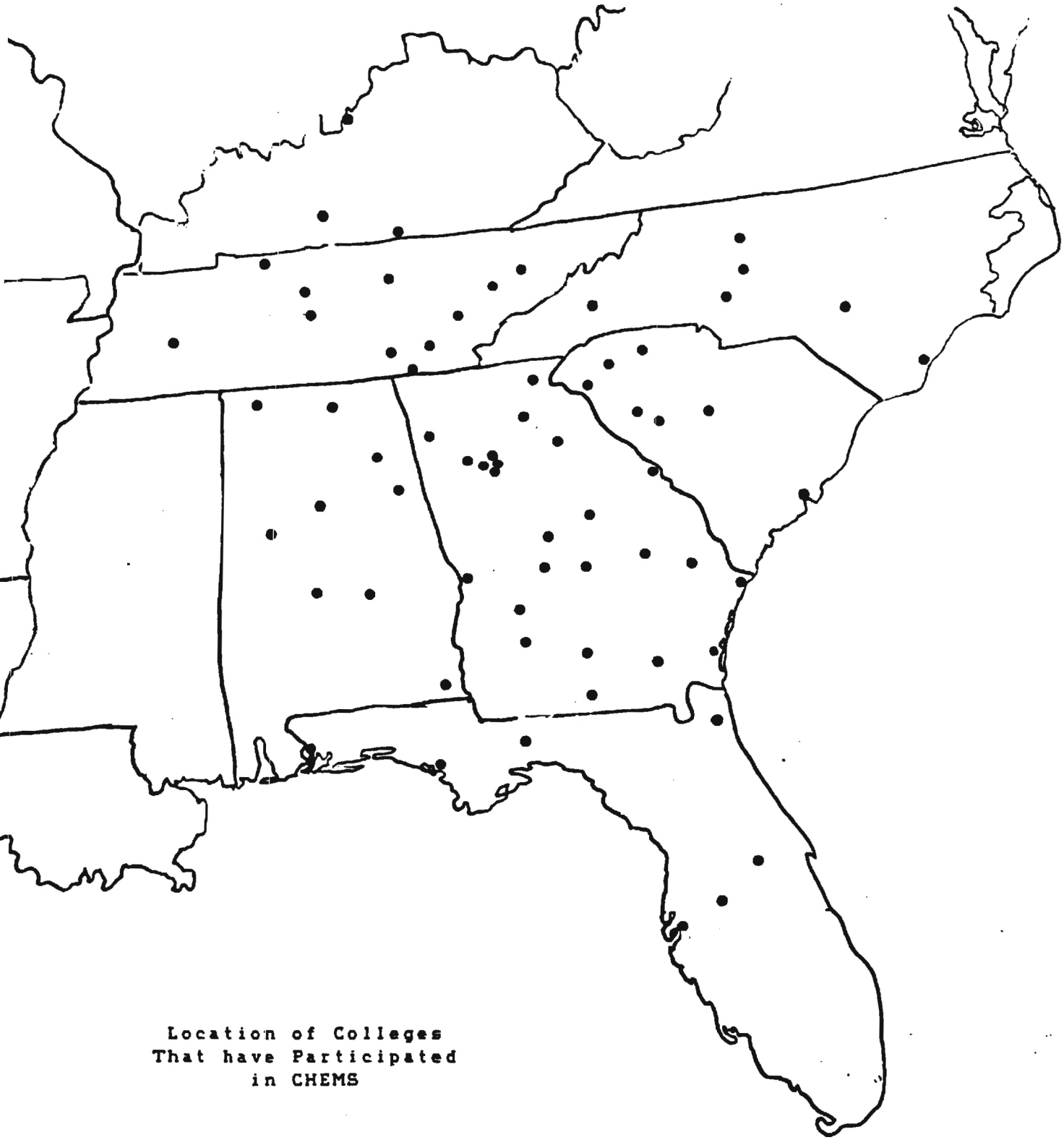
SATURDAY, OCTOBER 18 (CONT.)

1:00-3:00 P.M. Recent Advances in Organic Instrumentation: Chromatography (Room 2-28 Boggs)

- 1:00-2:00 P.M. General Discussion of High Pressure Liquid Chromatography and Its Application in Vitamin Analysis and Research by Mr. W. L. Landen (Research Chemist, Atlanta District, FDA)
- 2:00-2:30 P.M. Research Applications of HPLC and Demonstration of HPLC Equipment by Dr. Howard Deutsch of Georgia Tech
- 2:30-3:00 P.M. Brief Presentation* by Workshop Participants on Chromatography

* Conference participants are encouraged to plan presentations. These presentations should be in the range of 5-10 minutes; the actual time allotted will depend on the number of presentations. The schedule will be adjusted, if necessary, to fit everyone in. If possible, notify Dr. Drury Caine before the session begins if you want to make a presentation. A slide projector (2 x 2), overhead projector, and chalkboard will be available for use in these presentations.

APPENDIX VII



Location of Colleges
That have Participated
in CHEMS

AMERICAN CHEMICAL SOCIETY
DIVISION OF CHEMICAL EDUCATION, INC.

184th ACS National Meeting

Kansas City, Missouri
Sept. 12-17, 1982

G.A. Crosby, Chairman
J.A. Bell, Secretary
J.W. Moore, Program Chairman

CHED

TUESDAY AFTERNOON - SECTION B - GENERAL (CONCLUDED) - G. Dirreen, Presiding

34. CHEMS: A COOPERATIVE APPROACH TO INSTRUMENT MAINTENANCE AND REPAIR.
J. Aaron Bertrand, Gerald E. O'Brien, and Harrie R. Buswell, School of Chemistry, Georgia Institute of Technology, Atlanta, GA 30332.

Since February, 1979, the Georgia Tech School of Chemistry, through an NSF CAUSE grant, has operated CHEMS (Chemical Electronics Maintenance Service) for undergraduate chemistry departments in the Southeast. A motor home, equipped as a maintenance and repair facility with living quarters for an electronics technician, visits participating institutions on a regular basis to maintain and repair electronics equipment; equipment can also be shipped or delivered to Ga. Tech for repair. The participating institutions are billed for the service on a cost basis. Approximately 45 institutions are participating at present and the approach has proved to be a cost-effective way of handling instrument maintenance. The organization and operation of CHEMS will be described